Privately Contributing to Public Goods over Time[*] - An Experimental Study -

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Abstract

Similar to Levati and Neugebauer (2001), a clock is used by which participants can vary their individual contributions for voluntarily providing a public good. As time goes by, participants either in(de)crease their contribution gradually or keep it constant. Groups of two poorly and two richly endowed participants encounter repeatedly the weakest link-, the usual average contribution- and the best shot-technology of public good provision in a within subject-design. Some striking findings are that the weakest link-technology fares much better than the other two technologies in terms of welfare, and that the willingness to voluntarily contribute is greatly affected by the (increasing or decreasing) clock mechanism.

Keywords Public goods, Voluntary contributions, Efficient provision, Clock mechanism

JEL-Classification: C72, C92, H41, D44

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1 Introduction

Most experimental studies on voluntary provision of public goods rely on one stage-decision processes (i.e. all partners independently and simultaneously decide about their contribution) neglecting that often participants can openly (i.e. in full view of others) vary their contributions over time.[1] Think for instance of committees organized to raise funds for the (re)construction of a church (in Italy churches are built with private money). The campaign to raise funds usually lasts several weeks. Contributors are not forced to fix their contribution at the beginning but can vary it till the last moment while observing (in an "ad hoc" list) if and how much others have contributed.

Our study aims at filling this gap in the public goods literature. It has been inspired by Levati and Neugebauer (2001), who study the average contribution mechanism with an ascending clock whose progressive ticks represent the individual contributions submitted by each player. Unlike Levati and Neugebauer, we do not use the clock as a mechanism enforcing contributions but as a device specifying the time during which the players are allowed to in(de)crease their contributions. Furthermore, we do not restrict ourselves to the standard average contribution-technology, but include the two extremal technologies where either the minimal or the maximal individual contribution determines the level of the public good.

We can, hence, study if and to which extent people's behavior is affected by procedures and technologies of public good provision. In typical public goods experiments (with simultaneous and independent decisions and average contribution-technology) one usually observes that people cooperate more than predicted by standard game theory although, in repeated settings, cooperation deteriorates over time (see Davis and Holt, 1993, and Ledyard, 1995, for surveys). Will such a result also hold when subjects can openly in(de)crease their contribution over time and when they face a different technology? Or will changes in the clock mechanism and in the public good technology modify individuals' willingness to make (substantial) voluntary contributions?

Providing subjects with a fixed time interval during which they *(i)* can in(de)crease their contributions, and *(ii)* are always fully informed about the present contributions of others allows to verify when exactly people contribute (and how much). Do subjects first look at how their partners in(de)crease contributions before in(de)creasing their own (as a theory of conditional co-

[1] An exception is Dorsey (1992), who studied the effects of real time revisions on voluntary contributions. In his experiment, subjects first had to decide a provision level which they then could revise any time before the end of the period.

operation would suggest[2])? Or is contributing behavior independent of what others do?

Since all participants in our experiment encounter successively all three technologies, this represents a within-subjects factor of our design. However, we distinguish two possible orderings of technologies with the average contribution-technology as the intermediate case. Thus, the orders of technologies are a between-subjects factor. We, however, do not expect the order of technologies to matter so that we hope to pool the data for the statistical analysis.

A second between-subjects factor concerns the direction by which the clock moves and by which participants can adjust their contribution level. Our hypothesis regarding the clock mechanism is that contributions will be larger with an increasing clock than with a decreasing one, at least for the weakest link (where the minimal contribution is decisive) and the average contribution-technology.[3]

In the following section 2 the three public goods games are more formally introduced and analyzed in order to derive their equilibrium and efficiency benchmarks. Section 3 provides details of the experimental procedures. The data are described and statistically analyzed in section 4 before concluding in section 5.

2 Theoretical models and benchmark solutions

We first specify the various situations which participants confronted in the experiment and then derive the (game-)theoretic and efficiency benchmarks, assuming (common knowledge of) rationality with respect to own material rewards.

Denote by $e_i \in \{\underline{e}, \bar{e}\}$ player i's endowment that i can invest in his contributions c_i to the public good (with $0 \leq c_i \leq e_i$) or keep for himself. For all possible contribution vectors $c = (c_1, \cdots, c_n)$ of the n (≥ 2) players, the technology specifies which amount y of the public good is produced by c. We distinguish:

- the weakest link-technology

  (WL) $\quad y(c) = w \cdot min\{c_1, \cdots, c_n\} \quad$ with $w > 1$,

[2] A conditional cooperator can be defined as an agent who is willing to contribute the more to a public good the more others contribute. Conditional cooperation has been studied experimentally by Croson (1998), Sonnemans et al. (1999), Fischbacher et al. (2000), Keser and van Winden (2000), and Brandts and Schram (forthcoming).

[3] With an increasing clock one gradually builds up positive emotions whereas a decreasing clock only allows for deteriorating effects. Once such processes are initiated, our intuition is that they are hard to stop due to self-fulfilling expectations.

- the average contribution-technology
  (AC) $y(c) = a \cdot \sum_{i=1}^{n} c_i$ with $a < 1$,
- and the best shot-technology
  (BS) $y(c) = b \cdot max\{c_1, \cdots, c_n\}$ with $b < 1$.

All three technologies have been used in experimental economics with the average rule (AC) being most popular. The experiment relies on the parameters:

$$\underline{e} = 5,\ \bar{e} = 15,\ n = 4,\ w = 3,\ a = 0.5, \text{ and } b = 0.92.$$

Subject's earnings from c are always:

$$u_i(c) = e_i - c_i + y(c) \qquad \text{for all } i = 1, \cdots, n.$$

In the standard case of simultaneous and independent choices c_i by all players i, the solutions are:

- (all) $c^* = (c_1^*, \cdots, c_n^*)$ with $0 \leq c_i^* = c_j^* \leq \underline{e}$ for all $i, j = 1, \cdots, n$, for (WL), and
- (only) $c^* = (0, \cdots, 0)$, for (AC) and (BS).

Due to $0 < a, b < 1$, the unique benchmark solution for (AC) and (BS) follows from the requirement that players rely on their unique undominated strategy. The multiplicity of equilibria for (WL) results from the fact that, due to $w > 1$, player i in a situation with $c_i < c_j$ (for all $j \neq i$), resp. $c_i > c_j$ (for some $j \neq i$), prefers to increase, resp. decrease, his contribution c_i. The problem to coordinate expectations on a vector c with equal components leads to multiple equilibria like in usual coordination games.

In our experiment, participants can either keep their contribution constant over time or gradually in(de)crease it starting either from $c = (0, \cdots, 0)$ in case of an increasing clock, or from $c_i = e_i$ for all i in case of a decreasing clock. In general, a strategy in such a setting is a simple stopping rule which specifies a stop level c_i^t for all previous histories at time t and all possible points in time that still offer player i the chance to vary his contribution. Describing benchmark solutions in such terms can be quite cumbersome. Therefore, we will describe the benchmark solutions mainly in terms of outcomes and, when specifying which behavior they require, by assuming that these outcomes will be reached in minimal time.

Due to $0 < a, b < 1$, the benchmark outcome is $c^* = (0, \cdots, 0)$ for (AC) and (BS), i.e. all players i never voluntarily contribute with an increasing clock, and repeatedly decrease their contribution till it reaches 0-level when the clock is decreasing. For (WL) with an increasing clock, player i will never increase

c_i if, for some other player j, the present level satisfies $c_j < c_i$. Thus, all levels $0 \leq c_i = c_j \leq \underline{e}$ for all i, $j = 1, \cdots, n$ are candidates of uniform stopping rules. Similarly for (WL) with a decreasing clock, player i will not keep c_i constant over time if the present constellation is described by $c_j < c_i$ for some other player j. Thus, all uniform contribution vectors with $0 \leq c_i = c_j \leq \underline{e}$ for all i, $j = 1, \cdots, n$ are equilibrium outcomes.

Efficiency as the alternative benchmark requires:

- $c^+ = (\underline{e}, \cdots, \underline{e})$, in case of (WL),
- $c^+ = (e_1, \cdots, e_n)$, in case of (AC), and
- c^+ with one $c_i^+ = \bar{e}$ for player i with $e_i = \bar{e}$ and $c_j^+ = 0$ for all other players $j \neq i$, in case of (BS).

Since for (BS) any positive contribution c_i with $c_i \leq c_j$ for some j is wasted, in case of (BS) efficiency excludes symmetry. In the experiment the parameters w, a, and b were chosen so that welfare maximization yields the same payoff for all three technologies.

Behaviorally it should matter whether the clock is increasing or decreasing. Quite generally, we expect higher contribution levels when the clock is increasing, at least for the weakest link and the average contribution technology. The clock enables subjects to monitor others' contributions before deciding to in(de)crease their own. With an increasing clock, if a subject makes the first step to raise contributions, he can expect (or hope) that others will follow due to positive reciprocity. With a decreasing clock, if a subject makes the first step to lower contributions, his group members will realize that their earnings from c are decreasing: Negative reciprocity would induce them to lower contributions as well. Our intuition is that both processes of reciprocal dynamics have self-stabilizing properties.

3 Experimental procedures

The rather short instructions (see Appendix A for an English translation) introduce first of all the basic setting of 4 person-groups with two A- and two B-participants each. The A-participants are the low-endowed subjects j who receive $e_j = \underline{e} = 5$ ECU (where 1 ECU = 0.1 DEM). The B-participants are the high-endowed subjects i who receive $e_i = \bar{e} = 15$ ECU. For each subject, his type is randomly determined at the beginning and then kept constant over the entire experiment.

The first part of the instructions also informs subjects about their task: Deciding how much of their endowment they want to contribute to a group project. The individual contributions can be varied over a time interval of three minutes, where with an increasing (decreasing) clock one can never go below (above) a previously reached level. During these three minutes, a subject is always fully informed about the current contributions of his partners and which of the other contributions result from A- and B-participants.

The second part of the instructions introduces the three technologies and the respective payoff functions, where $(e_i - c_i)$ is the amount kept. The instructions also inform participants about the multiple repetitions of the three games and the changes in the group-composition over time. In case of the order (WL), (AC) and (BS), participants first played the (WL)-game for four rounds: The first two rounds with the same three partners in a group randomly formed at the beginning of the experiment; the next two rounds with new partners in a group randomly formed before the third round. In the same way, participants played the (AC)-game and, at last, the (BS)-game, with random matching of subjects between and within technologies. Each subject played, therefore, a total of 12 rounds.

The other ordering of technologies followed the same pattern, simply by exchanging (WL) with (BS): (BS) was played first and (WL) last. Our procedure can be viewed as a compromise between a partner and a stranger design. The same 4 person-group played each of the three games twice what allows to distinguish between early (1^{st}) and late (2^{nd}) play by the same group. On the other hand, groups are randomly assembled every two rounds, so that we may also observe some effects of learning how to play a (once) repeated game.

After reading the instructions, subjects had to answer 6 control questions testing whether they understood the various public good environments (see Appendix B). We did not start the experiment before all subjects had correctly answered all questions.

The computerized experiments were conducted at Humboldt-University of Berlin.[4] Participants, mainly students of business administration and economics, were all volunteers recruited by mail-shot invitations. In total, we run 12 sessions: 6 with an increasing clock (in 3 of these sessions subjects experienced the technologies in the order: (WL), (AC), (BS); in the remaining 3 sessions they experienced them in the order (BS), (AC), (WL)) and 6 with a decreasing clock (with again 3 sessions for both orderings of technologies).

Each session involved 12 participants (with 6 participants of type A and 6 of type B) who could be randomly partitioned into three groups of size $n = 4$. A session lasted about one hour and subjects earned on average DEM 17

[4] The software was produced by means of Fischbacher (1999)'s *z-Tree*.

(approximately 8.5 Euro), ranging from a minimum of DEM 6.51 (3.25) to a maximum of DEM 25.82 (12.91). For an increasing (decreasing) clock the mean earnings were DEM 17.77 (16.31) with a standard deviation of DEM 5.64 (5.57). Average earnings reacted only weakly to the ordering of technologies as shown in Table 1.

<u>Insert Table 1 about here</u>

4 Experimental results

Our data are 1728 observed contributions to a public good (12 decisions for each of 144 subjects) collected in 12 sessions with 12 participants each. Each session employed either an increasing or a decreasing clock-mode and one of two different orderings of the three technologies. Our data file consists therefore of 3 (technologies) $\times$ 2 (orderings of technologies) $\times$ 2 (movements of clock) = 12 dimensions (see Table 2).

<u>Insert Table 2 about here</u>

In reporting our results we proceed as follows. We first document and analyze behavior in the increasing clock-mode. Then we take into account the decreasing clock-mode. Finally we compare the two modes.

4.1 The data from the increasing clock-mode

We first control whether there are behavioral differences between the two orderings of technologies [(WL), (AC), (BS) vs. (BS), (AC), (WL)]. Tables 3a and 3b list for all rounds $t = 1, \cdots, 4$ and for each of the three technologies: the mean contributions, their standard deviations and the median contributions with respect to the two different orderings. Table 3a concentrates on the order (BS), (AC), (WL) and Table 3b on the order (WL), (AC), (BS).

<u>Insert Tables 3a and 3b about here</u>

Comparing the two tables, one notices that they do not differ much. Non parametric Wilcoxon rank sum tests conducted separately for the three technologies do not reject the null hypothesis that mean contributions are the same for the two orderings ($p = 1$ for BS; $p = 0.663$ for AC; $p = 0.686$ for WL). However, since in the applied tests possible dependencies within the data (due to the imperfect stranger design) are neglected, one might argue that the tests are not truly informative. To further justify data pooling every statistical analysis of the pooled data was also conducted separately for each ordering what, however, never revealed essential differences.

Table 4 replicates Tables 3 with pooled data where, of course, now the position of (WL), resp. (BS), does not reflect their timing.

<u>Insert Table 4 about here</u>

A first general tendency can be described by:

Observation 1 *The (BS)-technology consistently triggers much smaller contribution levels than the other two technologies whose contributions do not differ significantly.*

Observation 1 is evident from Table 4 and Figure 1, visualizing the average contributions in each of the four rounds for each technology.

<u>Insert Figure 1 about here</u>

For instance, in (WL) and (AC) the average contribution over all 4 rounds is almost five times higher than in (BS), and the median contribution is 5 in both (WL) and (AC) versus 0 in (BS). Comparing mean contributions of the three games for each round, we find that in (WL) and (AC) subjects contribute between two and eleven times more than in (BS).[5]

On the other hand, mean contributions in (WL) do not differ much from those in (AC). A non-parametric Wilcoxon signed ranks test (two-tailed) with averages as observations confirms that the difference in mean contributions between (WL) and (AC) is not significant ($p = 0.273$). Whereas when comparing (WL), resp. (AC), with (BS) the null hypothesis that average contributions are the same can be rejected ($p = 0.068$ in both cases).

If all subjects behave according to the efficiency benchmarks, mean contributions should be 10 in case of (AC), 5 in case of (WL) and only 3.75 in case of (BS). Thus, one could expect lower average contributions under the (BS)-technology. What impresses, however, is the huge discrepancy between the efficient and the actual values for (BS): Except for the first round, in all three remaining rounds the actual mean contributions are only about a quarter of the efficient level.

How do average contributions evolve over the 4 rounds of the three games? Remember that, in our experimental procedure, group members are randomly re-assigned to new groups every two rounds (stranger-design) so that the same 4 person-group plays each game twice (partner-design), and that in repeated

[5]Striking in this regard is the 4^{th} (and last) round where the ratio between mean contribution in (WL) and mean contribution in (BS) is 11.29.

public goods experiments (mostly of the (AC)-type) subjects in the initial stages contribute around halfway between the efficient and the equilibrium level but less towards the end. This decay is generally observed both in stranger and partner design, which our matching protocol tries to combine.[6] In agreement with the previous results we can report the following:

Observation 2 *In case of (AC), the average contribution in the initial period is half of the efficiency level and decreases over the 4 rounds irrespective of the new group composition in $t = 3$. This pattern applies also to (BS), while for (WL) the average contribution is nearly efficient and increases slightly over time.*

According to Table 4 and Figure 1, in $t = 1$ the average contribution is close to 5 for (AC) and 1.88 for (BS) and, thus, about one half of the efficiency levels. In contrast, in $t = 4$ the average contribution is slightly below 4 for (AC) and slightly above full defection for (BS). A completely different pattern is observed for (WL) where the average contribution is 4.43 in $t = 1$ versus 4.97 in $t = 4$. Figure 1 visualizes the evident downward trend in case of both (AC) and (BS) and the upward trend in case of (WL).[7]

Let us now investigate the efficiency levels in more detail. Recall that the maximal welfare (of 80) is the same for all three technologies. We thus can simply compare welfare levels to verify which technology (if any) is (more) efficient. The regularity in this regard is:

Observation 3 *The welfare levels vary significantly across technologies with (WL) being best and (BS) being worst.*

Observation 3 is supported by Tables 5 and 6. Table 5 reports separately for each technology the average levels of welfare in each round as well as (in the last row) the overall welfare.

Insert Table 5 about here

Over all 4 periods, the average welfare is 74.03 in (WL) (this value being very close to the optimal one) versus 57.39 in (AC) and 47.97 in (BS). Wilcoxon signed ranks tests (two-tailed) reject the null hypothesis that average welfare is

[6] Comparisons between partners and strangers contributions are studied experimentally by Andreoni (1988), Weimann (1994), Croson (1996), and Burlando and Hey (1997).

[7] Partitioning the 4 periods of each game into the first half (periods 1-2) and the second half (periods 3-4), with group averages as observations, to take account for the within-technology re-matching of subjects confirms that the first "two-period-groups" contributed significantly more than the second "two-period-groups" in (BS) and (AC) but not in (WL) [Wilcoxon signed ranks test, one tailed, $p = 0.0005$ for (BS); $p = 0.028$ for (AC); and $p = 0.854$ for (WL)].

the same in the three games ($p = 0.068$). Table 6 contains further information about efficient behavior under the three technologies. It reports for each of the 18 groups their payoffs for all four rounds and all three technologies.

<u>Insert Table 6 about here</u>

For both (BS) and (AC), the optimal welfare level is reached by no group in $t = 1$, by 2 groups (11.1%) in $t = 2$ and 3, and by 1 group (5.5%) in $t = 4$. In sharp contrast, in case of (WL), groups maximizing social welfare are: 8 (44.4%) in $t = 1$, 14 (77.8%) in $t = 2$, 13 (72.2%) in $t = 3$, and 15 (83.3%) in $t = 4$.

How is individual behavior affected by individual endowments and different technologies? For an analysis which takes into account the difference in received endowments, Tables 7a and 7b repeat Table 4 by reporting some descriptive statistics separately for poorly and richly endowed participants. Table 8 shows, for each round and each technology, the relative percentages of own endowment contributed on average by the two types of subjects.

<u>Insert Tables 7a, 7b and 8 about here</u>

For (BS), where efficiency requires that in each group only one richly endowed subject contributes his whole endowment, we report the following result:

Observation 4 *Under the (BS)-technology, relative (and absolute) contributions by poorly and richly endowed subject are not significantly different and equilibrium play emerges as the behavioral regularity for all subjects.*

Table 8 clearly shows that throughout the four rounds of (BS) the percentages of own endowment contributed by poor and rich subjects are very close. On average, rich subjects contribute 9.77 percent of their endowment which resembles the 9.03 percent contributed by poor subjects. Using averages of relative contributions as observations, we cannot reject the null hypothesis that contributions of rich and poor subjects under (BS) are the same (Wilcoxon rank sum test, $p = 0.886$, two-tailed).

According to Tables 7a and 7b, the median contribution over all 4 rounds is exactly 0 for both endowment levels and the average contribution is 0.45 in case of low endowment and 1.47 in case of high endowment. The frequency of poor and rich subjects who contribute zero is listed in Table 9. It shows that, under (BS), most subjects contribute zero independently of their endowment.

<u>Insert Table 9 about here</u>

Furthermore, the numbers of rich subjects who contribute 1 ECU (i.e. who deviate by at most 10 percent of their endowment from 0-level) are: 9 (25%), 4 (11.11%), 5 (13.89%) and 3 (8.33%) in t = 1, 2, 3 and 4 respectively. The efficient benchmark is seldom observed: Four subjects (11.11%) contribute 15 in $t = 1$, two subjects (5.56%) in $t = 2$ and 3, and only one subject (2.78%) in $t = 4$. These numbers are far from the efficiency requirement according to which, in each round, 18 rich subjects should be contributing their whole endowment. In view of this evidence one can conclude that the behavior of all subjects is well described by the equilibrium benchmark of not contributing.

Next, we consider the (AC)-technology. Here efficiency requires that each group member must contribute the whole endowment. Again experimental evidence contradicts the efficiency hypothesis.

Observation 5 *Under the (AC)-technology, relative contributions by poor and rich subjects differ significantly. The behavior of poorly endowed subjects is reasonably well described by the efficiency benchmark whereas richly endowed subjects contribute much lower shares.*

First evidence for Observation 5 is given by Table 8. A comparison of the AC-columns shows that the poorly endowed subjects contribute in each round a higher percentage of their own endowment than the richly endowed subjects. Aggregating over rounds, the average relative contributions for $e = 5$ is 75% while it is 33% for $e = 15$. The difference is therefore highly significant (p = 0.0286) according to a nonparametric Wilcoxon rank sum test (two-tailed) with averages of relative contributions as observations. Table 9 reveals that, under (AC), equilibrium play (i.e. $c_i = 0$) occurs more frequently for $e = 15$ than for $e = 5$ although the median contribution over all rounds is 5 for both endowment types (see Tables 7a and 7b).[8] Thus, under the (AC)-technology, full contributions emerges as the dominant behavioral standard only for the poorly endowed subjects.[9]

[8]Of altogether 36 poor subjects 22 (61.11%) in $t = 1$, 21 (58.33%) in $t = 2$, 19 (52.78%) in $t = 3$ and 14 (38.89%) in $t = 4$ contribute the whole endowment whereas the respective frequencies in case of rich subjects are 2 (5.56%), 5 (13.89%), 4 (11.11%) and 3 (8.33%). Moreover, while 13.9 percent of poor subjects in t = 1, 3 and 16.7 percent in t = 2, 4 deviate by only 1 (absolute) point from the efficiency benchmark of $c_i = 5$, the overwhelming majority of rich subjects deviate by more than 6 (absolute) points from $c_i = 15$ so that the frequency of 4, 5 and 6 ECU is higher than that of other contribution levels.

[9]The richly endowed subjects contribute on average just one third of their endowment. They thus stop contributing at the level above which the poor cannot go. Although they cannot feel especially entitled (see Hoffman and Spitzer, 1985), rich individuals are reluctant to contribute their whole endowment when there are poor individuals who cannot donate more than a certain amount.

Finally, we consider the (WL)-technology where efficiency requires that all group members contribute 5. Previous aggregate data analysis already indicated that (WL) fares quite well in terms of welfare. The behavioral regularities at the individual level confirm the aggregate result.

Observation 6 *Under the (WL)-technology, absolute contributions of poorly and richly endowed subjects do not differ significantly and the behavior of all subjects is reasonably well described by the efficiency benchmark.*

Again Tables 7a, 7b and Table 8 provide first indications. Tables 7a and 7b show that, throughout the four rounds of (WL), the mean contributions of poor and rich subjects are very close to each other and their median contributions are always 5. According to Table 8, poor subjects contribute on average almost their whole endowment whereas rich subjects contribute slightly above 30 percent of their endowment.[10] A Wilcoxon rank sum test (two-tailed) confirms that the percentage of own endowment contributed by poor subjects is significantly higher ($p = 0.0294$). When the same statistical test is performed (two-tailed) by using absolute contributions as observations, the null hypothesis that (absolute) contributions are the same for the two endowment types cannot be rejected ($p = 0.191$).

Recall that, in case of (WL), all uniform contribution vectors $0 \leq c_i = c_j \leq 5$ are equilibrium outcomes. Although the earlier figures do not leave much doubt that 5 contribution-level is the mode, it is worth considering if and how often group members coordinate on an equilibrium vector different from the efficient one. Table 9 reveals that only in the first round there is a small percentage (8.33%) of poor and rich subjects who contribute zero. They, however, do not prevent others from contributing more. On the other hand, the numbers of poor subjects who exhibit contributions in the range 1-4 are 7 (19.4%), 5 (13.9%), 4 (11.1%) and 3 (8.3%) in t = 1, 2, 3 and 4 respectively. The corresponding numbers in case of richly endowed subjects are 5, 4, 3 and 1 (2.8%). Again there is no coordination on low contributions. Thus, despite the multiplicity of equilibria in case of (WL) and the presence of the clock, the efficient choice is the only one upon which group members coordinate.

Taken together, the behavioral evidence as summarized in Observations 4 to 6 shows that the willingness of people to voluntarily contribute is greatly affected by the technology of public good provision and by different endowments.

[10] A deeper analysis of individual contributions reveals that the frequencies of contributing 5 for poorly endowed subjects are 26 (72.22%), 31 (86.11%), 32 (88.89%) and 33 (91.67%) in t = 1, 2, 3, 4 respectively. The analogous frequencies for richly endowed subjects are 24 (66.67%), 31, 31 and 33.

More specifically, Tables 7b and 8 suggest that rich participants contribute on average (at least) one third of their endowment in case of (AC) and (WL) and switch to opportunistic behavior in case of (BS). Poor subjects are very close to full contribution under (WL) and (AC) and to full defection under (BS) where, however, 0 contribution-level is their efficient choice. Hence, while poor subjects appear to behave efficiently throughout the three technologies, rich subjects are in line with the efficiency requirement only in case of (WL).

4.2 The data from the decreasing clock-mode

As for the increasing clock mode, we first control whether there are behavioral differences between the two orderings of technologies [(WL), (AC), (BS) vs. (BS), (AC), (WL)]. Tables 10a and 10b replicate Tables 3a and 3b for the decreasing clock mode.

<u>Insert Tables 10a and 10b about here</u>

Also in this case, we cannot reject the null hypothesis that mean contributions are the same for the two orderings ($p = 0.468$ for BS, $p = 0.886$ for AC, $p = 0.486$ for WL; Wilcoxon rank sum tests, two-tailed). Thus we again pool the data over all sessions employing the decreasing clock. Table 11 reports descriptive statistics using pooled data.

<u>Insert Table 11 about here</u>

Parallel to the analysis of the previous section, we first compare the average absolute contributions under the three technologies.

Observation 7 *The (BS)-technology triggers less contributions than the other two technologies also in the decreasing clock-mode.*

Besides being evident from Table 11, Observation 7 is supported by Wilcoxon signed rank tests (two-tailed) confirming that the difference in mean contributions between (WL), resp. (AC), and (BS) is statistically significant ($p = 0.068$ in both cases) whereas the difference between (WL) and (AC) is not ($p = 0.715$).

How average contributions evolve over time is summarized by:

Observation 8 *For all three technologies, the average contribution in the initial period is less than half of the efficiency level. In case of (AC) and (BS), the average contribution declines when the same groups repeat the game (partner design-effect) and sharply increases in $t = 3$, when groups are re-matched. In case of (WL), average contribution increases over time irrespective of new group composition in $t = 3$.*

Evidence for Observation 8 can be found in Table 11 and Figure 2, which visualizes the "restart effect" for (AC) and (BS),[11] and an upward trend for (WL).

Insert Figure 2 about here

Tables 12 and 13 inform about the levels of welfare under the decreasing clock mode. Table 12, resp. Table 13, displays the average welfare, resp. the group-payoffs, in each round separately for each technology.

Insert Tables 12 and 13 about here

Observation 9 *The welfare level is higher in the (WL)-technology than in the other two technologies whose average welfare levels do not differ significantly.*

From the last row of Table 12 (the "all-row"), the average welfare is 61.65 in (WL) versus 51.50 and 50.07 in (AC) and (BS) respectively. Wilcoxon signed rank tests (one-tailed) show that the difference in average welfare between (AC) and (BS) is not significant ($p = 0.625$) whereas the average level of welfare under (WL) is significantly higher than that under the other two technologies ($p = 0.057$ for both comparisons). Table 13 reveals that in case of (BS) the optimal welfare level is reached by two groups (11.1%) in $t = 1$, by no group in $t = 2$, and by three groups (16.7%) in $t = 3$ and 4. In case of (AC), the optimal welfare level is reached by no group in $t = 2$ and by two groups in $t = 1$, 3 and 4. Finally, in case of (WL) the numbers of groups who realize welfare maximization are 2, 8 (44.4%), 10 (55.5%), 14 (77.8%) in $t = 1$, 2, 3 and 4 respectively.

Regarding the difference in received endowment, Tables 14a and 14b inform about mean, median and standard deviations of poor and rich subjects' absolute contributions under each technology. Table 15 displays the relative percentages of own endowment contributed by the two types of subjects separately for each technology.

Insert Tables 14a, 14b and 15 about here

Analogous to the previous section, we start analyzing behavior in (BS) where we observe the following regularity:

Observation 10 *Under the (BS)-technology, rich subjects contribute on average significantly more than poor subjects. Nevertheless, the equilibrium benchmark of not contributing remains the modal behavior of both types of subjects.*

[11] See Andreoni (1988) for a definition and explanation of the restart effect.

A comparison of Table 14a and Table 14b shows that, throughout the four rounds of (BS), the mean absolute contributions of the rich subjects are higher than those of the poor subjects. Table 15 confirms that, under (BS), rich subjects contributed between 1.5 times (round 1) and 9.2 times (round 4) more of their endowment than poor subjects. Therefore, the difference turns out to be significant ($p = 0.02$) according to a Wilcoxon rank sum test (two-tailed). Moreover, Tables 14a and 15 reveal that poor subjects' average contributions are very close to zero in all rounds. What already suggests that equilibrium-like behavior occurs frequently when $e = 5$. This is verified by Table 16, which displays the frequencies and percentages of zero contributions in each round of the three technologies separately for rich and poor subjects. According to Table 16, in each round of (BS), more than 30 poor subjects (86%) contribute nothing.

Insert Table 16 about here

Consider now the frequencies of zero contributions in case of rich subjects. They are quite impressive as well: In each round of (BS), more than 27 rich subjects (75%) fully free-ride. It seems therefore that the (BS)-technology induces equilibrium play regardless of the endowment level and the clock mode. The detected difference in contributions according to received endowment can be explained by the fact that the rich subjects who do not free-ride contribute their whole endowment.

For the (AC)-technology, we report the following result:

Observation 11 *Under the (AC)-technology, there is no significant difference between relative (and absolute) contributions by poor and rich subjects and the modal behavior of all subjects is the equilibrium benchmark.*

Table 15 shows that, in (AC), poor subjects contribute on average 34 percent of their endowment, which resembles the 27 percent contributed by rich subjects. A Wilcoxon rank sum test (two-tailed) confirms that the relative contributions by rich and poor subjects under (AC) are the same ($p = 0.686$). According to Tables 14a and 14b, over all rounds of (AC), the median contribution is zero for both endowment types. Table 16 indicates that a quite remarkable number of poor and rich subjects contribute zero. Thus, in the decreasing clock-mode, the (AC)-technology mainly induces equilibrium behavior.

With respect to (WL), the data support the following observation:

Observation 12 *Under the (WL)-technology, absolute contributions of poor and rich subjects do not differ significantly. Average absolute contributions* *steadily increase over time and converge towards the efficiency benchmark of 5 for both endowment types.*

Tables 14a and 14b reveal that, throughout the four rounds of (WL), mean absolute contributions of rich and poor subjects are very similar: Both mean contributions exhibit an upward trend and approach the level of 5 in the final round. Table 15 makes it evident that the relative contribution rises toward 1 in case of poor subjects and toward 0.30 in case of rich subjects.[12] A Wilcoxon rank sum test with average contributions as observations does not reject the null hypothesis that average absolute contributions are the same for both endowment types ($p = 1$).

Given the existence of multiple equilibria in case of (WL), we investigate if group members coordinate on an equilibrium vector different from the efficient one. Aggregating over all 4 repetitions of each session and over all 6 sessions (for a total of 3 (groups) $\times$ 4 (repetitions) $\times$ 6 (sessions) = 72 groups), we find that 17 groups (23.6%) coordinate on contributions smaller than 5 (15 of them coordinate on the full free-riding equilibrium). This result sharply contrasts with the one for an increasing clock where an extraordinarily high number of subjects coordinate on the efficient choice and no coordination on fewer contributions was observed.

4.3 Comparing the two clock-modes

Are contribution levels higher with an increasing clock than with a decreasing one, at least for (AC) and (WL)? Both, an aggregate data analysis neglecting different endowments and an individual data analysis accounting for these support our basic hypothesis concerning the clock mode. Comparing Table 4 to Table 11 (or Figure 1 to Figure 2) shows that mean (aggregate) contributions depend on the clock mode in case of (AC) and (WL) but not in case of (BS). Wilcoxon rank sum tests (two-tailed) confirm that subjects contribute on average significantly more with an increasing clock under (AC) and (WL) ($p = 0.0571$, resp. 0.0286), while under (BS) average contributions in the two clock-modes are not significantly different ($p = 0.486$).

Taking into account the difference in received endowments, in case of (BS) the equilibrium benchmark of not contributing is the modal behavior of both endowment types with both an increasing and decreasing clock. In case of (AC) and (WL) individual contributions depend, however, on the movements

[12] The frequencies of poor subjects contributing 5 are 11 (30.56%), 20 (55.56%), 20 and 22 (61.11%) in $t = 1, 2, 3, 4$ respectively. The corresponding frequencies in case of rich subjects are: 9 (25%), 20, 20, and 28 (77.78%).

of the clock. To provide formal statistical evidence for the effect of the clock on both types of subjects, we performed a series of Wilcoxon rank sum tests (two-tailed) using as observations the mean absolute contributions of poorly and richly endowed subjects under the two clock modes. According to the tests, average contributions of both poor and rich subjects are significantly different in the increasing clock mode for (AC) and (WL) (in case of (AC) $p = 0.0286$ if $e = 5$ and $p = 0.0343$ if $e = 15$; in case of (WL) $p = 0.0571$ if $e = 5$ and $p = 0.0286$ if $e = 15$). The null hypothesis that average contributions of poor, resp. rich, subjects do the same in the two clock-modes cannot be rejected for (BS) ($p = 0.561$, resp. 0.343).

Thus, enabling conditional cooperation by employing an increasing or a decreasing clock does not leave people's behavior unchanged, as game theory would suggest. Rather, it greatly affects their willingness to contribute. This holds true regardless of people's initial endowment.

5 Conclusions

Given the abundance of public goods experiments (of which Ledyard, 1995, reviews only the tip of an iceberg) it seems necessary to justify our study. We partly avoided the usual structural symmetry of public goods experiments by distinguishing always two poorly and two richly endowed participants.

Furthermore, we did not focus only on the usual average contribution-technology but let all participants confront three structurally different technologies ((WL), (AC), (BS)) repeatedly. From our analysis it becomes obvious that most participants react in a systematic and predictable way to the differences in technologies.

Most importantly, we used a clock mechanism to allow for conditional cooperation, in the sense that participants can link their contributions to those of other group members. And, again, we did this rather systematically by distinguishing two clock modes, one ascending and the other descending, which allow participants to adjust their contributions upwards, resp. downwards.

In our view, only such a systematic attempt can reveal why in public goods-social dilemma situations people sometimes cooperate and sometimes free-ride. Let us just mention a few robust results:

- The relative contributions of poor and rich participants are rather similar under both clock-modes for (BS) and for (WL), where the equilibrium, resp. the efficiency, benchmark is the modal behavior of all subjects.

- Among the three technologies (WL) plays a special role triggering a higher welfare level than (BS) and (AC) regardless of the clock mode.
- An ascending clock induces higher contribution levels than a descending one only in case of (AC) and (WL).

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Table 1: Mean earnings for the two clock mechanisms and order of technologies.

Movement of clock	*Order of technologies* WL, AC, BS	BS, AC, WL
Up	17.86 (5.60)	17.68 (5.76)
Down	16.52 (5.59)	16.11 (5.61)

Note: The numbers in brackets are the standard deviations.

Table 2: Summary of experimental treatments and sessions.

Movement of clock	*Order of technologies*	*Experienced technologies* WL (BS)	AC	BS (WL)
Up	WL - AC - BS	3 Sessions		
	BS - AC - WL	3 Sessions		
Down	WL - AC - BS	3 Sessions		
	BS - AC - WL	3 Sessions		

Table 3a: Mean absolute contributions in all 4 rounds separately for each of the 3 games when played in the order (BS), (AC), (WL) with respect to the increasing clock-mode.

	BS				AC				WL			
t	1	2	3	4	1	2	3	4	1	2	3	4
Mean	1.86	0.89	0.64	0.67	4.53	4.14	4.22	3.86	4.81	4.72	4.69	4.89
Std Dev	3.68	2.65	2.53	2.60	2.84	3.63	3.41	3.49	3.02	0.74	0.89	0.32
Median	0.00	0.00	0.00	0.00	5.00	4.50	4.00	4.00	5.00	5.00	5.00	5.00

Table 3b: Mean absolute contributions in all 4 rounds separately for each of the 3 games when played in the order (WL), (AC), (BS) with respect to the increasing clock-mode.

	WL				AC				BS			
t	1	2	3	4	1	2	3	4	1	2	3	4
Mean	4.06	4.78	4.94	5.06	4.97	4.97	4.17	3.81	1.89	0.72	0.78	0.22
Std Dev	1.71	0.80	0.71	0.23	2.92	3.94	3.30	3.14	3.62	2.56	2.71	0.87
Median	5.00	5.00	5.00	5.00	5.00	5.00	5.00	4.00	1.00	0.00	0.00	0.00

Table 4: Mean absolute contributions in all 4 rounds separately for each of the 3 games with data pooled over all sessions employing an increasing clock.

	BS					AC					WL				
t	1	2	3	4	*All*	1	2	3	4	*All*	1	2	3	4	*All*
Mean	1.88	0.81	0.71	0.44	0.96	4.75	4.56	4.19	3.83	4.33	4.43	4.75	4.82	4.97	4.74
Std Dev	3.63	2.59	2.60	1.93	2.79	2.87	3.79	3.33	3.30	3.34	2.47	0.76	0.81	0.29	1.37
Median	0.50	0.00	0.00	0.00	0.00	5.00	5.00	4.50	4.00	5.00	5.00	5.00	5.00	5.00	5.00

Table 5: Average welfare in all 4 rounds separately for each of the 3 games under the increasing clock-mode.

t	BS	AC	WL
1	53.35	59.00	65.61
2	47.61	58.44	76.33
3	46.98	56.78	75.39
4	43.94	55.33	78.78
All	47.97	57.39	74.03

Table 6: Group payoffs in each round of the three games under the increasing clock-mode.

	BS				AC				WL			
Groups	1	2	3	4	1	2	3	4	1	2	3	4
1	43	40	42	40	67	72	57	51	80	80	80	80
2	43	43	47	48	48	43	49	47	79	80	80	80
3	47	45	40	40	51	49	44	41	70	80	80	80
4	73	45	40	40	57	72	65	66	34	53	70	71
5	44	40	40	42	64	60	60	57	80	80	41	69
6	53	80	43	40	71	62	80	80	69	69	80	80
7	43	53	43	40	61	61	52	58	70	80	80	80
8	51	45	40	40	44	42	50	45	33	80	80	80
9	79	43	80	80	60	52	55	54	80	80	80	80
10	79	43	42	43	51	45	41	45	80	80	80	80
11	51	50	53	43	64	80	80	79	79	53	80	80
12	78	43	80	43	54	51	55	50	35	80	78	78
13	45	43	40	40	58	59	60	61	80	80	80	80
14	49	42	43	40	60	60	59	57	42	80	49	80
15	42	43	40	40	60	57	59	48	80	80	80	80
16	43	80	40	40	79	80	42	45	30	79	79	80
17	53	40	53	53	61	59	56	55	80	80	80	80
18	43	40	40	40	52	48	58	57	80	80	80	80

Note: Groups from 1 to 9 played the games in the order (BS)-(AC)-(WL). Groups from 10 to 18 played the games in the reverse order. Group-composition changed randomly every two rounds.

Table 7a: Mean absolute contributions of the poorly endowed subjects in each round of the 3 games under the increasing clock-mode.

	BS					AC					WL				
t	1	2	3	4	*All*	1	2	3	4	*All*	1	2	3	4	*All*
Mean	0.89	0.42	0.44	0.06	0.45	4.19	3.89	3.69	3.25	3.76	4.03	4.67	4.75	4.92	4.59
Std Dev	1.43	1.08	1.25	0.23	1.13	1.24	1.70	1.75	1.81	1.66	1.72	0.89	0.84	0.28	1.11
Median	0.00	0.00	0.00	0.00	0.00	5.00	5.00	5.00	4.00	5.00	5.00	5.00	5.00	5.00	5.00

Table 7b: Mean absolute contributions of the richly endowed subjects in each round of the 3 games under the increasing clock-mode.

	BS					AC					WL				
t	1	2	3	4	*All*	1	2	3	4	*All*	1	2	3	4	*All*
Mean	2.86	1.19	0.97	0.83	1.47	5.31	5.33	4.69	4.42	4.94	4.83	4.83	4.89	5.03	4.90
Std Dev	4.76	3.48	3.47	2.69	3.73	3.82	4.97	4.35	4.25	4.34	3.01	0.61	0.78	0.29	1.58
Median	1.00	0.00	0.00	0.00	0.00	5.00	5.00	4.00	4.00	5.00	5.00	5.00	5.00	5.00	5.00

Table 8: Relative percentages of contributed endowment in each round of the 3 games separately for poor and rich subjects under the increasing clock-mode.

	$e = 5$			$e = 15$		
t	BS	AC	WL	BS	AC	WL
1	0.18	0.84	0.81	0.19	0.35	0.32
2	0.08	0.78	0.93	0.08	0.36	0.32
3	0.09	0.74	0.95	0.06	0.31	0.33
4	0.01	0.65	0.98	0.06	0.29	0.34
All	0.09	0.75	0.98	0.10	0.33	0.33

Table 9: Frequency and percentage of zero contributions in each round of the three games separately for poor and rich subjects under the increasing clock-mode.

		$e = 5$					$e = 15$				
t		1	2	3	4	*All*	1	2	3	4	*All*
BS	F	20	28	30	34	112	16	26	29	29	100
	%	55.56	77.78	83.33	94.44	77.78	44.44	72.22	80.56	80.56	69.44
AC	F	1	3	3	4	11	4	5	7	4	20
	%	2.78	8.33	8.33	11.11	7.64	11.11	13.89	19.44	11.11	13.89
WL	F	3	0	0	0	3	3	0	0	0	3
	%	8.33	0.00	0.00	0.00	2.08	8.33	0.00	0.00	0.00	2.08

Table 10a: Mean absolute contributions in all 4 rounds separately for each of the 3 games when played in the order (BS), (AC), (WL) with respect to the decreasing clock-mode.

	BS				AC				WL			
t	1	2	3	4	1	2	3	4	1	2	3	4
Mean	1.58	1.03	0.61	0.75	3.72	1.17	4.47	3.56	2.64	3.67	3.81	3.89
Std Dev	3.74	2.95	2.66	2.97	4.80	3.60	5.27	4.71	2.11	2.15	2.03	2.11
Median	0.00	0.00	0.00	0.00	0.00	0.00	4.50	1.50	3.00	5.00	5.00	5.00

Table 10b: Mean absolute contributions in all 4 rounds separately for each of the 3 games when played in the order (WL), (AC), (BS) with respect to the decreasing clock-mode.

	WL				AC				BS			
t	1	2	3	4	1	2	3	4	1	2	3	4
Mean	2.11	2.61	2.81	4.17	4.81	2.17	1.61	1.31	1.08	0.83	2.17	0.83
Std Dev	2.95	2.49	2.12	1.70	5.75	4.22	3.34	3.65	3.16	3.16	4.81	3.48
Median	0.00	2.00	2.00	5.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 11: Mean absolute contributions in all 4 rounds separately for each of the 3 games with data pooled over all sessions employing a decreasing clock.

	BS					AC					WL				
t	1	2	3	4	*All*	1	2	3	4	*All*	1	2	3	4	*All*
Mean	1.33	0.93	1.39	0.79	1.11	4.26	1.67	3.04	2.43	2.85	2.38	3.14	3.31	4.03	3.21
Std Dev	3.45	3.04	3.94	3.22	0.39	5.29	3.93	4.61	4.33	0.57	2.56	2.37	2.12	1.91	0.29
Median	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	2.00	5.00	5.00	5.00	5.00

Table 12: Average welfare in all 4 rounds separately for each of the 3 games under the decreasing clock-mode.

t	BS	AC	WL
1	52.25	57.06	50.50
2	47.32	46.67	60.11
3	52.23	52.17	64.78
4	48.49	49.72	71.22
All	50.07	51.40	61.65

Table 13: Group payoffs in each round of the three games under the decreasing clock-mode.

	BS				AC				WL			
Groups	1	2	3	4	1	2	3	4	1	2	3	4
1	78	75	40	40	50	40	54	41	69	80	72	80
2	40	40	40	45	68	40	55	66	39	47	40	40
3	51	48	40	40	55	41	80	77	38	80	80	80
4	40	60	40	67	40	75	48	55	36	40	80	80
5	80	40	80	80	67	45	40	40	40	39	80	80
6	48	40	43	40	64	40	75	40	80	26	39	40
7	56	40	56	40	70	40	80	80	44	80	80	80
8	40	40	40	40	40	40	49	50	64	80	80	80
9	53	40	40	40	40	41	40	40	47	80	80	80
10	40	40	80	40	40	40	43	40	40	39	40	39
11	67	40	47	40	40	40	50	40	40	80	45	80
12	52	40	40	40	76	41	40	40	40	40	80	80
13	40	40	80	40	80	46	44	41	79	78	80	80
14	80	40	40	40	80	40	41	80	80	80	80	80
15	40	40	78	80	78	51	47	41	40	80	80	80
16	40	77	75	40	58	41	40	45	39	53	40	80
17	40	40	40	40	40	74	44	40	54	40	45	43
18	54	72	40	80	41	65	69	40	40	40	45	80

Note: Groups from 1 to 9 played the games in the order (BS)-(AC)-(WL). Groups from 10 to 18 played the games in the reverse order. Group-composition changed randomly every two rounds.

Table 14a: Mean absolute contributions of the poorly endowed subjects in each round of the 3 games under the decreasing clock-mode.

	BS					AC					WL				
t	1	2	3	4	*All*	1	2	3	4	*All*	1	2	3	4	*All*
Mean	0.47	0.22	0.36	0.06	0.28	2.36	0.58	2.00	1.92	1.72	2.28	3.08	3.31	4.06	3.18
Std Dev	1.34	0.68	1.20	0.33	0.98	2.44	1.46	2.35	2.38	2.28	2.17	2.35	2.15	1.90	2.22
Median	0.00	0.00	0.00	0.00	0.00	1.50	0.00	0.00	0.00	0.00	2.00	5.00	5.00	5.00	5.00

Table 14b: Mean absolute contributions of the richly endowed subjects in each round of the 3 games under the decreasing clock-mode.

	BS					AC					WL				
t	1	2	3	4	*All*	1	2	3	4	*All*	1	2	3	4	*All*
Mean	2.19	1.64	2.42	1.53	1.94	6.17	2.75	4.08	2.94	3.99	2.47	3.19	3.31	4.00	3.24
Std Dev	4.56	4.15	5.28	4.44	4.59	6.58	5.17	5.94	5.64	5.95	2.93	2.42	2.12	1.94	2.42
Median	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.50	0.00	0.00	1.00	5.00	5.00	5.00	5.00

Table 15: Relative percentages of contributed endowment in each round of the 3 games separately for poor and rich subjects under the decreasing clock-mode.

	$e = 5$			$e = 15$		
t	BS	AC	WL	BS	AC	WL
1	0.09	0.47	0.46	0.15	0.41	0.16
2	0.04	0.12	0.62	0.11	0.18	0.21
3	0.07	0.40	0.66	0.16	0.27	0.22
4	0.01	0.38	0.81	0.10	0.20	0.27
All	0.06	0.34	0.64	0.13	0.27	0.22

Table 16: Frequency and percentage of zero contributions in each round of the three games separately for poor and rich subjects under the decreasing clock-mode.

		$e = 5$					$e = 15$				
t		1	2	3	4	*All*	1	2	3	4	*All*
BS	F	31	32	32	35	130	27	30	28	32	117
	%	86.11	88.89	88.89	97.22	90.28	75.00	83.33	77.78	88.89	81.25
AC	F	17	29	19	20	85	17	26	18	26	87
	%	47.22	80.56	52.78	55.56	59.03	47.22	72.22	50.00	72.22	60.42
WL	F	14	11	8	5	38	15	12	7	6	40
	%	38.89	30.56	22.22	13.89	26.39	41.67	33.33	19.44	16.67	27.78

Figure 1: Mean absolute contributions in all 4 rounds separately for each of the 3 games under the increasing clock-mode.

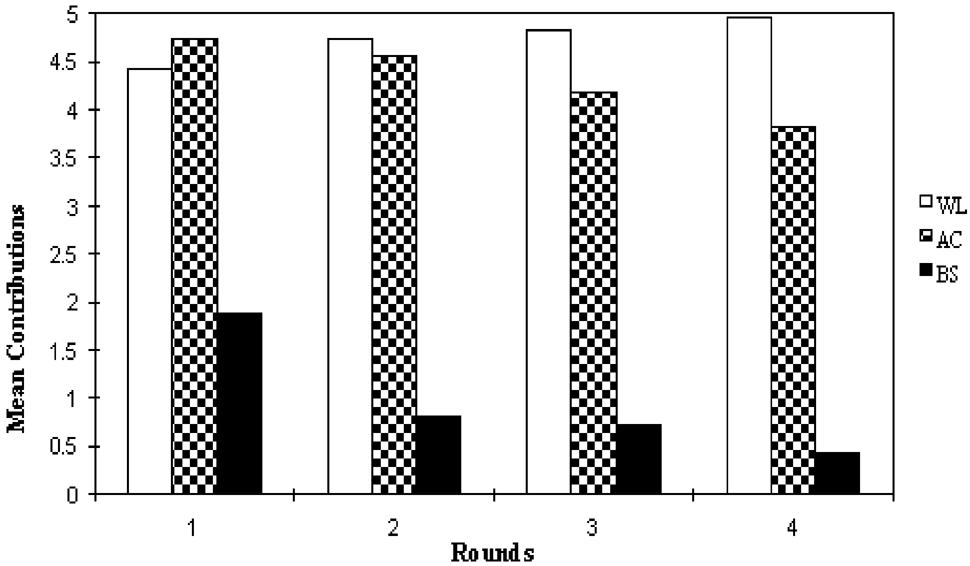
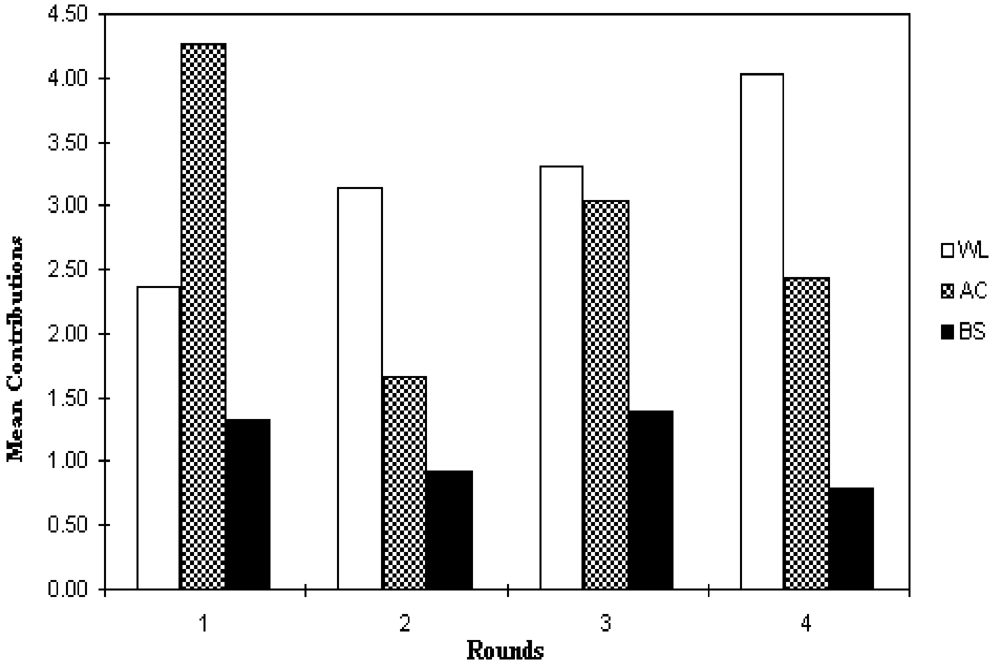


Figure 2: Mean absolute contributions in all 4 rounds separately for each of the 3 games under the decreasing clock-mode.



Appendix A: Experimental Instructions

The following instructions were originally written in German. We report the instructions that we used under the increasing clock-mode when the technologies were played in the order (BS)-(AC)-(WL). The instructions for the decreasing clock-mode and the reverse order of technologies were adapted accordingly.

Welcome and thanks for participating in this experiment. Please, do not talk to the other people in the room. If you have any question, raise your hand and we will come to help you.

The instructions are identical for all participants.

The experiment will consist of 3 subsequent parts of 4 periods each. In each period you can earn money. The experimental money will be the ECU, where 1 ECU = 0.10 DEM. There will be two types of players: A and B. Your type will be determined at the beginning and you will keep it over the entire experiment.

The 3 parts will differ only in how your payoff will be calculated. Their basic structure will be the same.

<u>Structure of a round</u>

In each round, four participants will interact with each other: Two participants of type A and two participants of type B. The group composition, first determined at the outset of the experiment, will then be randomly changed every two rounds. This means that you will interact with the same three persons twice.

If you are an A-participant, you will receive an endowment of 5 ECU per round. If you are a B-participant, your endowment will be 15 ECU per round. From this endowment you can pay a certain part c to a project. You will keep for yourself the rest (i.e., the part not given to the project). You will have 3 minutes (i.e., 180 seconds) for deciding about the amount that you want to give to the project. During this time you can either increase your contribution from 0 (which is the starting point) or leave it unchanged. Once you have decided to give a certain amount, you can raise it again but you can never lower it.

While the 3 minutes go by, you will be continuously informed about the actual level of contributions of your partners. You will also know which type (A or B) decides to contribute.

The contribution levels of the 4 fellow members at the end of the three minutes will represent their round decisions. These decisions will determine your earnings whose calculation varies with the different parts of the experiment.

Round Income

Part 1 (Rounds 1 $\rightarrow$ 4)

From the contributions c_i of all participants $i = 1, 2, 3, 4$ the maximum contribution will be chosen and multiplied by 3.66. The resulting amount will then be equally divided among the 4 group members independently of how much each of them has contributed. Your round income I_i will be calculated by adding the amount that you kept for yourself, k_i [i.e. $(5 - c_i)$ for A- and $(15 - c_i)$ for B-participants], to your payment from the project:

$$I_i = k_i + \frac{3.66}{4} max\{c_1, c_2, c_3, c_4\}.$$

Part 2 (Rounds 5 $\rightarrow$ 8)

The contributions c_i of all participants $i = 1, 2, 3, 4$ will be summed up, multiplied by 2 and then divided equally among the 4 group members independently of how much each of them has contributed. Your round income I_i will be calculated by adding the amount that you kept for yourself, k_i, to your payment from the project:

$$I_i = k_i + \frac{2}{4} \sum_{i=1}^{4} c_i.$$

Part 3 (Rounds 9 $\rightarrow$ 12)

From the contributions c_i of all participants $i = 1, 2, 3, 4$ the minimum contribution will be chosen and multiplied by 12. The resulting amount will then be equally divided among the 4 group members independently of how much each of them has contributed. Your round income I_i will be calculated by adding the amount that you kept for yourself, k_i, to your payment from the project:

$$I_i = k_i + \frac{12}{4} min\{c_1, c_2, c_3, c_4\}.$$

The sum of all 12 round incomes will determine the payment that you will receive from the experiment.

Appendix B: Control Questionnaire

Please answer the following questions:

1. Assume that you are an A-participant (i.e., you are endowed with 5 ECU). Nobody in your group - including yourself - contributes any ECU to the project. Please, calculate your round income in each of the three parts of the experiment.

   ▷ Part 1: $\cdots$

   ▷ Part 2: $\cdots$

   ▷ Part 3: $\cdots$

2. Assume that you are an A-participant. All persons in your group - including yourself - contribute the whole endowment to the project. Please, calculate your round income in each of the three parts of the experiment.

   ▷ Part 1: $\cdots$

   ▷ Part 2: $\cdots$

   ▷ Part 3: $\cdots$

3. Assume that you are a B-participant (i.e., you are endowed with 15 ECU). You contribute 10 ECU to the project. How much is your round income in each of the three parts of the experiment if the other B-participant contributes 0 and both the two A-participants contribute their full endowment (i.e., 5 ECU each)?

   ▷ Part 1: $\cdots$

   ▷ Part 2: $\cdots$

   ▷ Part 3: $\cdots$

N.B. You can answer each question either by just writing the formula or by rounding up the numbers.